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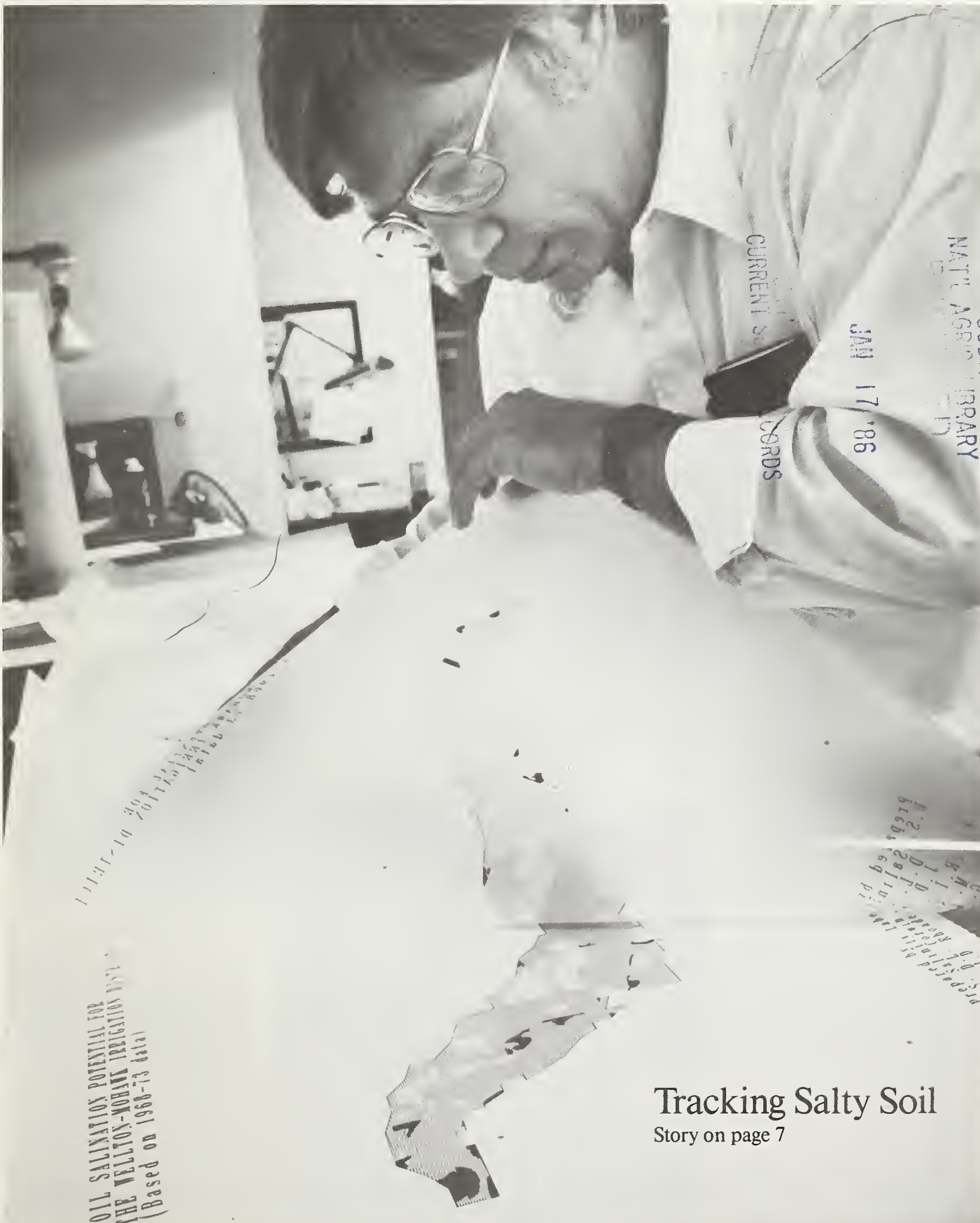


Tracking Salty Soil

Story on page 7

Scientist Thwarts Yield-Robbing Fungi

The Agricultural Research Service has named plant pathologist R. James Cook the 1985 Distinguished Scientist of the Year for protecting the world's leading food grain from root diseases. The award is the highest given by the Agency for scientific achievement and leadership among its employees.

This year's recipient is a scientist who believes that modern wheat still falls short of its true potential yield. His research, spanning 20 years at the Agricultural Research Service's Root Disease and Biological Control Unit in cooperation with Washington State University at Pullman, WA, bears out this conclusion.

As one of the world's leading authorities on fungal diseases of wheat, Cook has found ways to reduce the effects of three major root diseases attacking wheat in the principal wheat-growing areas of the Pacific Northwest.

In the critically eroding fields of eastern Washington and northern Idaho, conservation tillage's chances for adoption were boosted when Cook discovered that the fungus *Pythium* was limiting conservation tillage wheat yields to 60 to 75 percent of their potential.

Conservation tillage is a practice that reduces erosion by limiting the amount of soil disturbed by tillage and leaving as much of the previous crop's residue on the surface as is needed to protect the soil. Growers in the Palouse have been slow to accept conservation tillage because of lowered wheat yields.

Cook says the residue left on the field acts like a wet blanket, keeping soil cool and damp, which is very conducive to growth of *Pythium* and other soil fungi.

Once the real culprit was known, Cook's research team went on to isolate an antibiotic-producing bacterium that can colonize wheat roots and protect them from *Pythium.* Cook is also testing seeds coated with a chemical control for the disease.

In drier production areas of the Pacific Northwest, Cook and his colleagues found that the key to controlling another disease, *Fusarium* foot rot, was to keep wheat plants from becoming stressed for water. They recommended reducing the amount of nitrogen applied to reduce leaf size, planting late to keep plants smaller, and choosing varieties bred to withstand water stresses. In a 100,000-acre area afflicted by *Fusarium,* wheat farmers who followed these recommendations increased their yields by about 10 bushels per acre.

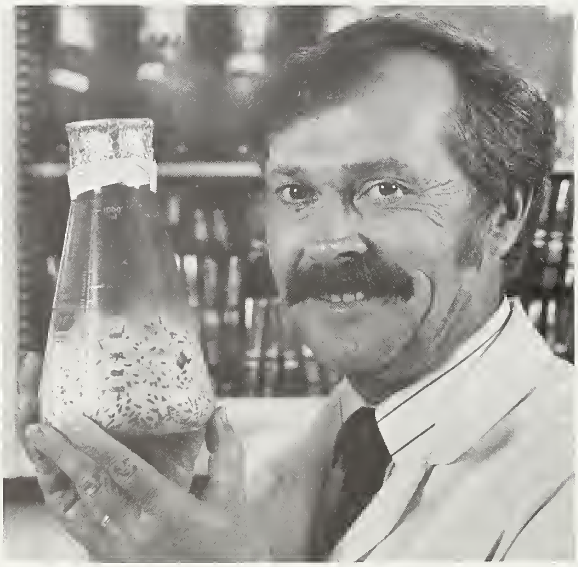
Another disease—aptly named "take-all" by Australian pioneers—is the world's most important wheat root disease. It is caused by the fungus *Ophiobolus graminis.* Cook began studying take-all in 1967 and as a result of research on the ecology and general biology of the soil fungus, found ways to control it by managing tillage, irrigation, fertilizers, and soil acidity.

Farmers raising wheat on the irrigated acres of the Columbia Basin of Washington and the Snake River Plain of southern Idaho do not find take-all as drastic as the name implies but still consider it a serious problem. Growers who packaged Cook's recommendations into a management program averaged 110 to 120 bushels per acre (in 1982), even in fields where wheat was planted for several years in a row.

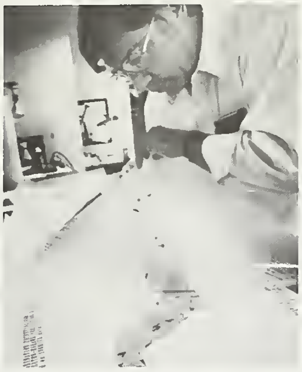
A bacterium that suppresses take-all is in its fifth year of field-testing. To do this work, Cook and plant pathologist David M. Weller, have developed and patented a way to separate effective strains of bacteria from the many ineffective strains.

Possibly more important than a bacteriological approach to take-all control is discovery of a potential self-destruct mechanism in the fungus itself. The scientists know the mechanism is genetically controlled but need to examine it further as a possible biological control tool. Cook says Linda S. Thomashow, a molecular geneticist, joined him and Weller this year so the team could pursue this line of research.

The chance to work with Cook and his colleagues on wheat research has attracted visiting scientists and students from England, Australia, Brazil, Japan, Korea, the People's Republic of China, Thailand, France, and Germany, as well as from within this country. Many are now making significant scientific contributions in their own right.—**L.E.M.**


Cook with laboratory culture of root rot fungus. (1085X1040-4)

Agricultural Research



Cover: Agricultural Research Service soil scientist James Rhoades, Riverside, CA, looks at computer-made overlay maps showing areas of irrigated land with potential salt problems. Techniques developed by Rhoades and others should help predict salinity trouble spots throughout the world. Story begins on page 7. (1185X1215-26A)

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Have You Had Your Chromium Today?

Probably not. A week-long test of the normal diets of 32 adults in the Washington, DC, area revealed that all consumed less than the recommended amount.

The National Academy of Sciences suggests a minimum of 50 micrograms of chromium a day as safe and adequate.

For the test at the Vitamin and Mineral Nutrition Laboratory in Beltsville, MD, 32 volunteers brought in duplicate amounts of everything they ate and drank. Then the food was analyzed for amounts of vitamins and minerals.

Another test at the Vitamin and Mineral lab showed those who exercise strenuously may need more chromium than others. The nine men studied lost twice as much chromium in their urine on days they ran 6 miles than on days they did not run.

Physical stress caused by severe injuries seems to have an effect similar to exercise. In cooperative studies at the University of Maryland's Neurotrauma Intensive Care Unit in Baltimore, seven severely injured patients lost abnormally high amounts of chromium in their urine. The rate of chromium loss decreased as the patients recuperated, according to chemist Marilyn M. Polansky.

Chemists Mary Howard (left) and Marilyn Polansky take a blood sample from chemist Richard Anderson. Anderson, a jogger, participated in a study of the effect of strenuous exercise on blood sugar and chromium levels. (0584W546-21)

Richard A. Anderson, also a chemist, says tests at the lab have revealed that chromium maintains blood-sugar levels and helps regulate fats and cholesterol, even increasing high-density lipoproteins (HDL), the "good" cholesterol.

Anderson says foods such as whole wheat breads, meat, mushrooms, and vegetables are good sources of chromium. A varied diet containing these foods can be expected to provide enough chromium to maintain good health.—**Vince Mazzola,** Beltsville, MD.

Richard A. Anderson and Marilyn M. Polansky are at the USDA-ARS Vitamin and Mineral Nutrition Laboratory, Room 224, Building 307, Beltsville, MD 20705. ■

Antipollution Injection for Trees

A chemical injected into shade trees can reduce leaf damage from ozone pollution by as much as 94 percent.

Ozone, a major air pollutant, damages crops and causes tree leaves to yellow, wither, and fall. It also reduces vigor and growth, leaving trees vulnerable to attack by insects and disease.

Bruce R. Roberts, a plant physiologist with the Agricultural Research Service in Delaware, OH, has found that ethylenediurea (EDU) protects tree leaves from ozone damage.

"How EDU protects plants from ozone is not well understood. But our test results indicate that when it is injected directly into the stem, it alters enzyme and membrane activity within the leaf cells where photosynthesis takes place," Roberts says.

Tree seedlings were treated with the chemical by two different methods a week before being fumigated with ozone. Leaves were checked for damage within 6 days after fumigation.

The seedlings were exposed to 0.30 and 0.95 parts per million of ozone, well above the range normally found in smog.

Roberts and coworkers at the Nursery Crops Research Laboratory found injecting EDU into a small cut in the stem was more efficient than drenching the soil around potted seedlings.

Injecting honeylocust, red maple, pin oak, and sweetgum seedlings gave better protection—up to 94 percent compared with a high of 48 percent for drenching—using only one-fiftieth as much EDU solution.

Roberts chose 2-year-old seedlings so they would fit in the fumigation chambers but says EDU injection should protect mature trees as well. "We feel that EDU is a relatively safe chemical for protecting leaves of most trees and shrubs from ozone damage," he says.—**Betty Solomon,** Peoria, IL.

Bruce R. Roberts is at the USDA-ARS Nursery Crops Research Laboratory, 359 Main Road, Delaware, OH 43015. ■

In the Clover With Bigbee

A new winter-hardy clover has been developed for the southern United States.

William E. Knight, an agronomist with the Agricultural Research Service in Mississippi, said that Bigbee is the only berseem clover that can survive across the South. Berseem clovers, also called Egyptian clovers, are extensively cultivated in the Nile Valley and to some extent in the southwestern United States and California. These clovers are generally more succulent than alfalfa and other clovers.

Knight says the clover he named Bigbee "has a level of cold tolerance comparable to arrowleaf and crimson clover." It "will benefit livestock producers because it has more fall and winter growth than any other winter annual legume, with the exception of one variety of crimson clover. Moreover, Bigbee produces forage longer than any other winter legume and will grow late into May and even early June."

Although Bigbee is susceptible to root diseases common to other legume species, Knight says that none of his experimental stands have been lost to these diseases since he began the tests in 1977. Another advantage of the new clover to livestock producers is that not a single case of bloat (an often fatal accumulation of gas in the digestive system of ruminants) has ever been reported in animals feeding on berseem.

Finally, Bigbee differs from other berseems in that it produces an abundance of hard seed suitable for reseeding stands.

Breeder seed of Bigbee is being produced by ARS. Foundation seed is produced by the Mississippi Agricultural and Forestry Experiment Station, which participated in the release.—**Bennett Carriere,** New Orleans, LA.

William E. Knight is in USDA-ARS Forage Research, P.O. Box 272, Mississippi State, MS 39762. ■

Beyond the Root Zone

Forecasting potential effects on groundwater from pesticides will be easier because of changes in a prediction model.

The Chemicals Runoff and Erosion from Agricultural Management Systems (CREAMS) mathematical model has been modified to estimate the movement of pesticides below the root zone of crops. Previously, CREAMS estimated only movement across the land surface.

Limited testing of GLEAMS (Groundwater Loading Effects of Agricultural Management Systems), the new groundwater contamination part of CREAMS, gave relatively good results compared with observed data on sandy soils in the southeastern United States.

The next task will be to add the effects of nutrients, mainly nitrates, to the model.

The Agricultural Research Service and the USDA Soil Conservation Service are testing GLEAMS in central Wisconsin.

The model will be used in a groundwater research project, in cooperation with the U.S. Geological Survey, to simulate the movement of farm chemicals through root zones.

Walter G. Knisel, Jr., a hydrological engineer, and Ralph A. Leonard, soil scientist, are conducting this research at the USDA-ARS Southeast Watershed Research Laboratory, P.O. Box 946, Tifton, GA 31793. ■

Stored Grain Spraying—Less Water?

Using less water to apply BT, a bacteria-based insecticide, in stored grain has been found just as effective as using the rate printed on the package, says William H. McGaughey, an entomologist with the Agricultural Research Service in Manhattan, KS.

This should reduce the concern of grain producers about mold risks caused by too much water being applied to stored grain, he says.

The discovery came during tests of application methods and performance of insecticides made from the bacterium *Bacillus thuringiensis* (BT) on about 65 cooperating farms in Illinois, Iowa, Kansas, Nebraska, and Oklahoma.

Using two commercial formulas of the insecticide, in both dust and wettable formulations, researchers reduced infestations of the Indianmeal moth by 50 to 60 percent in stored wheat and by more than 80 percent in corn.

To determine the effectiveness of *Bacillus thuringiensis* (BT) applied to grain with various amounts of water, entomologist William McGaughey examines Indian meal moth pupae trapped in a spool of corrugated paper. The percentage of dead pupae reveals the insecticide's effectiveness. (0985X1056-29)

ARS scientists found the insecticide's effectiveness essentially the same whether applied in a dust formula or a wettable powder, whether added to the grain as it is augered into the bin or whether raked into the surface of filled bins.

However, scientists did find that using 4 gallons of water per 500 square feet to apply the wettable powder was just as effective as the labeled rate of 10 gallons per 500 square feet.

McGaughey warns that it's illegal for grain producers to use less than 10 gallons of water until BT manufacturers obtain the approval of the Environmental Protection Agency and the label has been changed.

In the 3-year tests, 142 bins of wheat and 43 bins of corn were treated with BT and insect levels

were measured and compared with those in 158 untreated bins.—**Linda Cooke-Stinson,** Peoria, IL.

William H. McGaughey is in USDA-ARS Biological Research at the U.S. Grain Marketing Research Laboratory, 1515 College Avenue, Manhattan, KS 66502. ■

New Weed Spreading in Upper Midwest

An annual weed common to northern China is becoming more of a problem for Minnesotans each year.

In 1984, Robert N. Andersen, an agronomist, and colleagues at the University of Minnesota, St. Paul, found prickly smartweed in more than 40 fields in 6 southern Minnesota counties and 1 northern Iowa county.

"Infestations ranged from only a few plants in a field to fields in which prickly smartweed was the dominant weed throughout the entire field," Andersen says. "The vigorous growth of the new weed in cropland suggests that it would be at least as competitive as the other annual smartweeds already well established in North America."

Prickly smartweed, identified as *Polygonum bungeanum* Turcz, is also found in Japan, Korea, Manchuria, and parts of the U.S.S.R. near Japan.

It differs from other common annual smartweeds found in the upper midwestern United States (ladysthumb, Pennsylvania smartweed, and pale smartweed) in that the plants of prickly smartweed develop tiny downward-pointing prickles and seeds that are almost round. Other smartweeds have no prickles, and the seeds are flat.

Prickly smartweed has not been reported previously as occurring in North America. "We have no idea how the weed came to this country," Andersen says. "It may have been introduced from Asia as long as 25 years ago."—**Betty Solomon,** Peoria, IL.

Robert N. Andersen is in USDA-ARS Plant Science Research at the University of Minnesota, Department of Agronomy and Plant Genetics, St. Paul, MN 55108. ■

Prickly smartweed (left) and Pennsylvania smartweed. (PN-7193)

Computer Simulates Ideal Forage Use

A computer model has been designed to help dairy farmers and researchers assess the impact of new methods for harvesting and storing forage under a wide range of management and climatic conditions.

Using local weather records dating back 26 years, C. Alan Rotz, Agricultural Research Service agricultural engineer, East Lansing, MI, used the model to find that in 9 years out of 10, harvesting alfalfa four times a year can be considered more profitable than cutting hay three times.

In developing the model, Rotz and graduate students at Michigan State University, East Lansing, integrated previous research results into submodels to predict the quantity and quality of alfalfa and corn produced under historical weather conditions. In a feeding submodel they allocated the highest quality feed to the high milk-producing cows. Other submodels dealt with harvest, storage, and handling of the forage.

In the overall model, predicted net dollar returns are compared for forage harvest and storage alternatives on dairy farms.—**Ben Hardin,** Peoria, IL.

C. Alan Rotz is assigned to the U.S. Dairy Forage Research Center, Madison, WI, and is in Room 207, Department of Agricultural Engineering, Michigan State University, East Lansing, MI 48824. ■

Chronic Obesity May Lead to Mineral Deficiency

Doctors have reported that some obese children and adolescents have low blood levels of iron and zinc. To study this phenomenon, scientists are turning to laboratory animals. In tests so far, obese rats do show significantly lower levels of zinc, iron, copper, and manganese in their tissues than their lean littermates.

Agricultural Research Service microbiologist Mark L. Failla is now studying the question of how chronic obesity alters tissue concentrations of these minerals and if marginal intake of minerals affects obese animals more severely than lean animals.

Mark L. Failla is at the USDA-ARS Beltsville Human Nutrition Research Center, Building 307, BARC-East, Beltsville, MD 20705. ■

Tracking Salty Soil, Saving Fresh Water

A pickup truck pulls off the highway and stops. A high school student gets out, removes a probe which is attached by wires to a backpack data recorder, swings the equipment over his back, and walks about 100 yards into an adjoining field. There he shoves the probe six inches into the soil and pushes a button to automatically record soil salinity and exact location in the field.

When several hundred such measurements have been recorded, the young employee returns to the local irrigation manager's office and electronically transmits the information into a computer. The computer, no larger than some home models, analyzes the information and prints a map that indicates areas where yield-reducing salts are accumulating in farmers' fields.

Agricultural Research Service scientists have developed the measuring probe, now commercially available, and the computer programs. They are now evaluating ways to make the large-scale collection of data economical, perhaps much like the technique portrayed above.

The USDA's Soil Conservation Service has contributed $100,000 this year to help make such soil salinity mapping possible.

Cooperating University of California geographer Stephen McRae (left) discusses salinity maps with soil scientist James Rhoades. (1185X1214-7A)

Salinity, and the resulting decreased crop yields, has been a problem for irrigated agriculture for at least 4,000 years. Mesopotamia, an area between the Tigris and Euphrates Rivers in what is now Iraq, once flourished with agriculture and civilization. Salinity associated with irrigation slowly doomed the area—today a vast semidesert supporting only half the population it once did.

Salinity still plagues irrigated lands. Some of this country's most productive farmland is being lost to this natural phenomenon that has been accelerated by irrigation. California has 8.6 million acres of irrigated land and about half, 4.5 million acres, is affected to some degree by salinity. Similar problems are occurring throughout the western United States.

Some estimates for foreign countries are particularly bleak. For example, one report estimates that 35 percent of India's irrigated land is seriously saline and that one-quarter to one-half of South America's irrigated acreage is adversely affected by salts.

"Estimates are educated guesses," says Jan van Schilfgaarde, former director of the U.S. Salinity Laboratory, Riverside, CA, "but until we develop ways to monitor the degree of increasing salinity, I won't argue with anyone who says we have a very serious problem both here and overseas."

"Long-term corrective action is needed to protect irrigated agriculture, but first we need to be able to detect the onset of problems and to predict where they will occur," says ARS soil scientist James D. Rhoades, Riverside.

Rhoades says salinity measuring is currently done in laboratories, and each sample can cost up to $25 with several dozen needed for each field. Such expense is prohibitive for mapping large areas.

"The sampling technique and maps we are developing will eliminate the major need for soil sampling and laboratory analysis. Cost figures haven't been calculated yet, but if we can get the system automated, it should cost a mere fraction compared with present techniques."

Maps that minimize the need for direct measurement use computer overlay techniques and can be

"I won't argue with anyone who says we have a very serious problem both here and overseas."

– Jan van Schilfgaarde.

likened to maps in some geography text books. Geographic features are printed on one page and additional information, such as how boundaries have changed over time, is printed on individual overlays made of clear plastic.

In this case, each overlay contains information on one factor that can contribute to salinity in soil.

These factors include water table depth, soil permeability, leaching fraction (the amount of excess irrigation water applied to leach salts below the root zone), and groundwater salinity. A composite of these factors defines areas of probable salinity development.

Several thousand pieces of information can be entered into the computer for each map. Then computer programs written by Dennis L. Corwin, formerly with ARS, manipulate the information.

The programs analyze values assigned to each salinity factor. When these values exceed an assigned number, the computer indicates a potential trouble area.

Armed with these maps, farmers and growers will be able to locate areas on their land where salt problems are likely to occur. They can then change the way they farm to avert or reduce damage. Such damage, unchecked, would not only put farmers out of business, but could permanently destroy the agricultural productivity of the land.

Government agencies will be able to use the maps to anticipate the extent and degree of future salinity problems and formulate policy.

Land use planners will be able to find best locations for industrial, commercial, and housing needs, locating these on more salt prone areas.

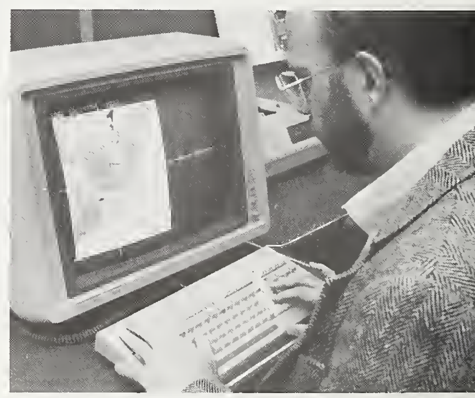
In California's Imperial Valley, Rhoades records data as research assistant Porfirio Pacheco takes readings from an electromagnetic soil salinity monitor. (1185X1218-24)

Rhoades developed the measuring probe which contains four electrodes. An electrical current flows through the soil—passing between the outside pair of electrodes. A meter indicates how much resistance the current flow encounters—a direct indication of salinity. Each poke of the probe measures a soil sample roughly 6 inches deep and 6 inches in diameter.

Rhoades is also using a salinity monitor that may make measurements even easier. It consists of a generator that produces an electromagnetic field that emanates invisibly from a 3-foot-long bar. This field causes an electric current flow within the soil that is proportional to salinity. With such electronic measuring devices, Rhoades determines how salty the soil is. As soil salt increases, the secondary current flow increases proportionally.

"I don't even have to lay the monitor on the soil. It gives a correct reading when suspended at hip height. And by rotating the magnetic field, I can determine salinity at specific depths."

"The ideal measuring device might be some form of this electromagnetic measurer. It is possible, in principle, to mount it on an all-



McRae prepares a computer-generated map to identify irrigated land with potential salt problems. (1185X1217-11A)

terrain vehicle or even suspend it from a low-flying aircraft. This would dramatically reduce the time and labor needed for data collection," Rhoades says.

"We're fairly confident with our present measuring devices and computer programs. Our biggest challenge will be matching our data with exact locations where we collected it," says Rhoades. He envisions someday using portable "direction finders" capable of receiving LORAN-type navigational radio beams either directly or relayed via satellite stations. Such systems are used commercially to aid ocean

Salt-laden wastewater flows from irrigated land in California's Imperial Valley into the Salton Sea (background). (1185X1220-15)

Christopher Colancino, research assistant at the University of California, Riverside, checks soil moisture and salinity for corn plants grown in a special container, called a lysimeter, to test the feasibility of reusing irrigation wastewater. (1185X1216-30A)

vessels and aircraft in routine navigation and to locate them in emergencies.

Strategy To Reuse Salt-Laden Water

"Not only are we concerned about reducing consumption of expensive water that could be better used for irrigating salt-sensitive crops and for urban and industrial demand, but we want to ensure that drainage water is not wasted, does not cause a disposal problem, nor that it become a source of pollution," Rhoades says.

He is referring to a potentially valuable resource—the excess water that drains from the state's $12 billion worth of irrigated crops each year. California may be generating upwards of 1.6 trillion gallons of subsurface drainage water annually—an amount of water roughly equal to what residents in New York City, Chicago, and Los Angeles use in 3 years.

Rhoades calculates that up to 70 percent of this can be reused. His approach to salvaging this water is to irrigate salt-sensitive crops with fresh water from wells and canals, then recycle what normally runs off as drainage water onto salt-tolerant crops.

He has already demonstrated that drainage water, now considered a waste because it has picked up salts as it flows down through soils, can be reused for irrigation. Some irrigators consider water containing more than 2,000 parts per million (ppm) salt too saline for crops. He successfully used water containing up to 6,000 ppm—one-sixth the salt concentration in sea water—to grow normal yielding crops.

With conventional irrigation, the amount of water that is applied depends on what crop is being grown, how old the plants are, and how hot the weather is. And irrigators must add to that amount enough more to keep water flowing downward so that salts accumulating in the soil are carried away from crop roots.

A new crop rotation strategy to use such brackish water for irrigation was the key element that Rhoades and cooperating researchers developed over the past few years at the U.S. Salinity Laboratory. They have three crop rotations under study.

The first rotation is wheat (a crop having intermediate salt tolerance), sugarbeets (a salt-tolerant crop), and then cantaloups (a salt-sensitive crop). These crops are being grown during a 2-year cycle in California's Imperial Valley.

Colorado River water, which contains about 900 ppm of salt and is considered good quality water, was used to saturate the soil before planting wheat and sugarbeets and for early irrigation. This water was also used for all irrigations of the melons.

The remaining irrigation water, for about the latter three-fourths of the growing season for wheat and sugarbeets, was drainage water containing about 3,500 ppm of salt. This water, if spread to a depth of 1

At the Imperial Valley Conservation Research Center in Brawley, CA, technician Robert Swain checks melons grown on land previously irrigated with salty wastewater. (1185X1219-6)

foot on the land and left to evaporate, would leave behind about 5 tons of salt per acre.

Another rotation tried in the Imperial Valley was cotton (a salt-tolerant crop) for 2 years, wheat for one season, and then alfalfa (a salt-sensitive crop) for several years.

All crop yields in the two studies thus far have been equal to yields from identical rotations that were irrigated with only fresh Colorado River water.

Cotton yielded an average 2.5 bales per acre, wheat 3.7 tons per acre, and sugarbeets 32 tons per acre.

The salt-containing drainage water made up 82 percent of the irrigation water applied to sugarbeets. For wheat, the percentage was 76, and for cotton it was 54.

Melons yielded 385 pounds of seed per acre on fields that had previously been irrigated with salty water for wheat and sugarbeet production. This yield equaled that from fields irrigated with only good water.

"The high melon seed yields indicate that even though salty water had been applied and was in the soil beneath their roots, proper irrigation management can restore these fields so salt-sensitive crops can flourish," says Rhoades.

The third experiment was on land in California's San Joaquin Valley, where saline ground-water exists in places just 2 to 3 feet below the soil surface.

Despite such an adverse environment, cotton and sugarbeet yields have been good—2.3 bales and 28 tons per acre, respectively—when irrigated with drainage water containing 6,000 ppm salt. Cotton and sugarbeets grown with California Aqueduct water containing 300 ppm salt yielded about a half bale more cotton but no more beets than the drainage water.

While these field studies continue, additional work is underway in the laboratory. A computer simulation model is being developed that Rhoades hopes to use for answering "What if. . ." questions such as "What will corn yield if a farmer applies water containing 3,000 ppm salt for 3 years?" or "How much fresh water with only 300 ppm salt must be applied to cropland that has been irrigated with drainage water before I can plant melons?"—**Dennis Senft,** Albany, CA.

James L. Rhoades is at the U.S. Salinity Laboratory, 4500 Glenwood Drive, Riverside, CA 92501. Jan van Schilfgaarde is now Director, Mountain States Area, 2625 Redwing Road, Fort Collins, CO 80526. ■

Rhizomania Threatens Sugarbeet Industry

The race is on—scientists versus rhizomania. Time is on the side of rhizomania.

Sometimes called "bearded root" because heavy growth of root hairs on the main taproot lends a hairy look, rhizomania is caused by a virus known as beet necrotic yellow vein. It is so named because in severe stages it causes yellowed or dead tissue in the leaf veins.

Rhizomania was first discovered in 1983 near Paso Robles, CA. Its devastating presence was confirmed in 33 fields containing about 2,500 acres. A year later, rhizomania had spread to 71 fields containing more than 6,000 acres and moved to other sugarbeet growing areas of the state. California is the nation's second largest sugarbeet producer.

Typically, rhizomania causes losses of 20 to 50 percent in infected fields and has been known to cause total crop failure. Sometimes plants will have good bulk growth but contain only 3 to 4 percent sugar content—much less than the 14 to 18 percent in normal sugarbeets.

The rhizomania virus may have been present in this country for some time before it was identified, according to an Agricultural Research Service scientist. Such symptoms as do occur in top growth—a mild yellowing of leaf veins or some wilting in extreme cases—may go unnoticed because they are similar to those associated with a plant food deficiency or lack of water. The fungus *(Polymyxa betae)* that transmits it was discovered in 1976 and has since been found (without the virus) in Kansas, Nebraska, and several Canadian provinces.

James E. Duffus, a plant pathologist at Salinas, CA, working on the rhizomania situation, says there is no known way to control the disease once a field is infected. Evidence indicates that it is practically impossible to totally disinfect the field by chemical or cultural means.

"Because the disease attacks the roots," Duffus says, "unless growers periodically dig some plants to check them, they won't know if beets are infected until almost harvest time. By then, they will already have invested about $600 per acre in fertilizer, irrigation water, and other inputs."

Duffus believes that the only long-term solution to the rhizomania problem may be resistant sugarbeet varieties. Robert T. Lewellen, a plant geneticist at Salinas, is screening both cultivated lines of sugarbeets and some of the sugarbeet's wild relatives for resistance. Of the 100 or so lines tested so far, 3 or 4 appear to be less susceptible to rhizomania. It is also known that *Beta maritima,* the wild parent of all cultivated sugarbeets, has some resistance.

"The problem is we do not know the nature of this resistance; that is, whether it is resistance to the fungus or the virus, or if it is just varying levels of tolerance to either the fungus or the virus," Lewellen says.

If a source of high resistance can be found that will provide a solid foundation for resistance breeding, Lewellen says, "resistant commercial varieties are a possibility within 8 years; if not, then we are looking at 10 to 20 years."

In addition to the more long-term approach through selective breeding, Duffus' research plans include development of a quick soil test that can be used in the field to determine if the fungus or virus is present.

Until such a test is available, soil samples must be checked by bringing them into a greenhouse and planting sugarbeets in them. After about 4 weeks of growth, the young sugarbeet plants are pulled and assayed for rhizomania infection. A direct soil test would eliminate the time and effort required for greenhouse work and help growers avoid planting in infested fields.

A second research aim is to learn more about the fungus that carries the rhizomania-causing virus. Some parts of the puzzle are known already. For example, rhizomania occurs most commonly when several things happen at the same time—the fungus and virus are both present, there is a relatively high soil temperature (68°F or 20°C and higher) over an extended period of time, soil moisture content is high, and soil pH is neutral to slightly alkaline.

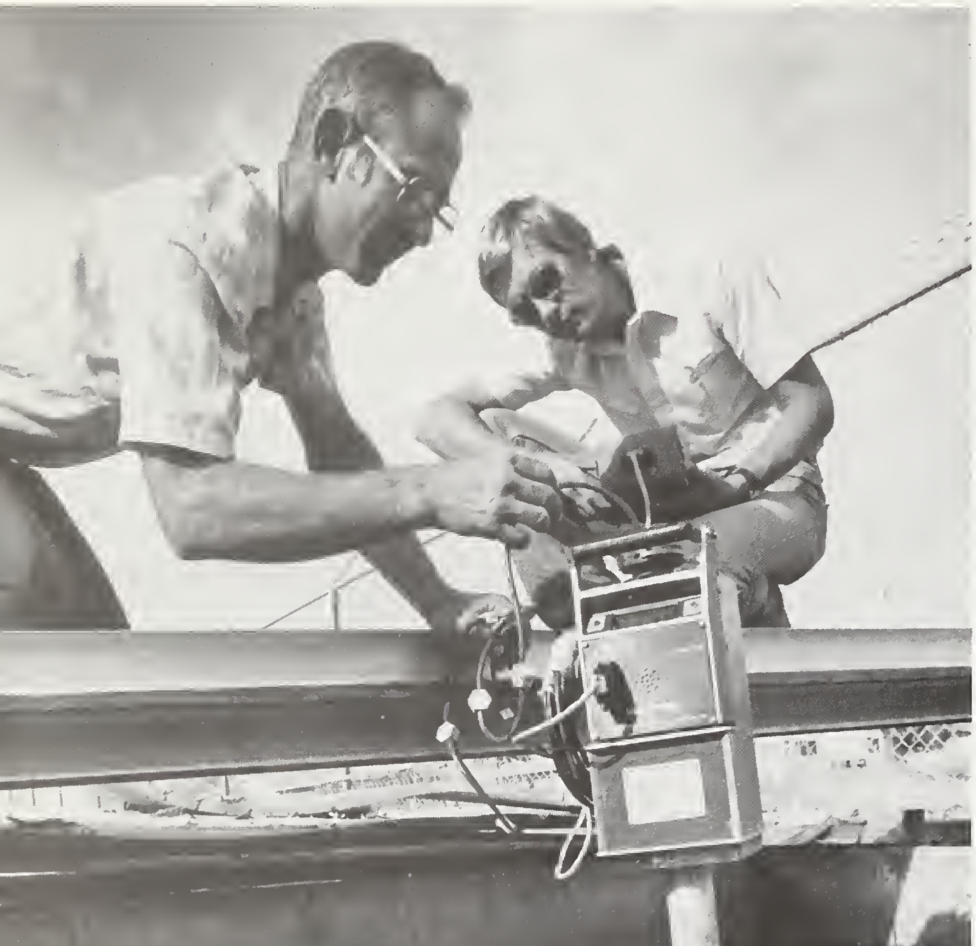
Plant pathologist James Duffus examines sugarbeet leaf for evidence of disease. (1082X1251-20)

The fungus that transmits the virus is moved by water through irrigation systems, by reuse of excess irrigation water after it drains from a field, by use of wash water from beet-processing plants for irrigation, by movement of beets from one growing area to another area for processing, and through movement of harvesting equipment from farm to farm.

Until resistant varieties are available, efforts should be made to prevent the spread of the fungus from one field to another.—**W. Jim Whorton,** Albany, CA.

James E. Duffus is in USDA-ARS Sugarbeet Production Research, U.S. Agricultural Research Station, 1636 East Alisal St., Salinas, CA 93905. ■

Groundwater Movement Studied



Using a neutron moisture probe, agricultural engineer Robert Rice (left) and soil scientist Robert Bowman monitor soil water changes during irrigation of one of their test plots. Tubing leads to soil water samplers placed at various depths. (0985X1013-15A)

Agricultural Research Service scientists in the West are tracing the paths by which irrigation water, along with any dissolved chemicals, takes shortcuts, bypassing part of the water already in the soil.

A separate study in Ohio shows that a single field application of a soluble chemical can raise chemical concentrations in groundwater for years.

Agricultural Research Service scientists in Phoenix, AZ, have timed the downward movement of water with chemical tracers and found rates faster than predicted by a commonly used procedure.

Robert S. Bowman, the ARS soil scientist who conducted the tests, used potassium bromide and four other chemicals to trace the percolation of water applied to test plots. With help from ARS agricultural engineer Robert C. Rice, he measured the chemical tracers at seven depths, down to 10 feet, to see how fast water moved.

On the average, the water moved more than 60 percent faster than previously calculated.

Intrigued by this finding, Rice extended the study to a 1½-acre field at the University of Arizona's Maricopa Agricultural Center. The results were even more striking—water moved up to six times faster than expected.

Bowman says, "How much new water bypasses old water is undoubtedly related to physical properties of the soil and subsoil, including how much sand and gravel are present. Another factor is the amount of water applied. The more water, the deeper the penetration of new water."

Bowman says information about water movement is important because chemical residues may move with the water, increasing the risk of contamination of groundwater supplies. Groundwater provides drinking water for an estimated 50 percent of the country's population. In addition, 40 percent of agricultural irrigation relies on groundwater supplies.

"The future of our groundwater," Bowman warns, "depends heavily upon our present management practices. This research shows the urgency of developing and refining those practices."

Herman Bouwer, director of the U.S. Water Conservation Laboratory in Phoenix says, "In the past, preferential flow of water through soil has been thought to be mainly associated with cracks, root holes, or worm holes. Our work shows that such flow can also occur in soils without large, obvious pores. This sheds new light on how fast chemicals move to groundwater and how predictions of such movements can be improved."

Bouwer says his laboratory staff will continue studies aimed at evaluating effects of irrigated agriculture on groundwater quality and recharge rates.

The research program has been expanded to include measuring the movement of chemicals, such as pesticides, which are carried downward with the recharge water.

In Beltsville, MD, scientists are monitoring the movement and fate of herbicides commonly used with no-till farming. Charles S. Helling, a soil scientist at the Pesticide Degradation Laboratory, says he has found that at least some fraction of the herbicides seem to move a lot faster than expected.

Since 1983, Helling and T.J. Gish, a soil physicist at the Hydrology Laboratory, have been sampling soil and groundwater on 15 no-till corn plots. The soil is typical of Coastal Plain stream valleys, with layers of clay, sand, and gravel.

On a separate tract of land, Gish is using bromide tracers to test the feasibility of predicting chemical movement in bare soils as well as those with crops.

In related research at the U.S. Salinity Laboratory in Riverside, CA, soil scientist Rien van Genuchten is modifying current models that predict chemical movement in soils to account for the preferential pathways that speed chemical movement. Van Genuchten is a cooperating University of California scientist.

William F. Spencer, an ARS soil scientist at the University of California at Riverside, has developed a model that traces all possible routes pesticides might take. Spencer developed this model in cooperation with scientists at the University of California.

Whatever route they take, once chemicals reach the water table they may stay there for a long time.

Soil scientist Lloyd B. Owens came to this conclusion after using potassium bromide to trace what happens to the nitrate form of nitrogen fertilizer after it is applied. Owens used bromide instead of nitrate because it moves through the soil much like nitrate and it is easier to trace.

Owens applied the bromide at the same rate commonly used to apply nitrate on pastureland. He found peak concentrations 21 to 24 months later in groundwater samples collected from springs supplied by the test watershed, and there was no significant decrease in concentration after 4 years.

To the farmer, lost nitrogen fertilizer is lost dollars. But the results of this research have broader implications because nitrate is considered a pollutant at high concentrations.

Owens says, "If more nitrate is applied than the plants can utilize, the impacts may be seen for several years. This study indicates that even a single application of a soluble chemical can have a multiyear influence on the quality of ground and surface water."—**Dennis Senft,** Albany, CA, and **Betty Solomon,** Peoria, IL.

Herman Bouwer, Robert S. Bowman, and Robert C. Rice are at the USDA-ARS U.S. Water Conservation Laboratory, 4331 East Broadway Road, Phoenix, AZ 85040. Lloyd B. Owens is in USDA-ARS North Appalachian Experimental Watershed Research, P.O. Box 478, Coshocton, OH 43812. ■

Top: Bowman checks soil and water samples that will be analyzed to determine concentrations of chemical tracers extracted from the soil. (0985X1013-30A)

Above: Technician Gladys Hauer and Bowman prepare to analyze samples with high-performance liquid chromatography. The technique allows measurement of up to seven different tracers simultaneously from a single sample. (0985X1012-30)

Temperature Integrator Reduces Spraying

A battery-operated device that measures heat from the sun may tell apple growers when it's time to spray for codling moths.

J. Franklin Howell, an Agricultural Research Service entomologist in Yakima, WA, developed the device—a temperature integrator—to monitor temperatures in orchards and provide cumulative degree-hour readings, much like an electric meter records kilowatt hours of electricity used.

"Precise timing is the key to effective spraying," says Howell. If the orchards are sprayed too early in the spring, pesticide effects wear off before the moths have completely emerged. If the spray goes on too late, larvae can enter the fruit where they are protected from pesticides. The codling moth is a major pest in apple orchards everywhere, especially in the West.

The system to determine spray times for codling moths consists of a temperature meter, or integrator, and a series of traps baited with chemical sex attractants (pheromones) placed throughout the orchard. The pheromone traps let the grower know when adult codling moths first begin to appear—usually about the end of apple blossom bloom. As soon as the first moth is trapped, the grower turns on the temperature integrator, which begins accumulating degree-hours. At about 2,000 degree-hours Celsius, the first codling moth egghatch should occur.

Correctly timed sprays will kill all adults and larvae that have emerged to that point as well as all adults that emerge from then on until the spray wears off, about 20 days later.

Howell says temperature integration can save growers up to 35 percent of their present cost of controlling the pest. It can eliminate time-consuming and—literally—fruitless spraying as well as the harm unnecessary spraying does to beneficial insects. Besides improving codling moth control in apple orchards, Howell says that a similar system could be adapted for use on other crops.—**Howard Sherman,** Albany, CA.

J. Franklin Howell is located at the Yakima Agricultural Research Laboratory, 3706 West Nob Hill Boulevard, Yakima, WA 98902. ■

Freeze-dried Seeds Really Last

When Lowell Woodstock returned to Beltsville in 1978 after 2 years in Saudi Arabia, he found that all the freeze-dried onion seeds he had left from earlier freeze-drying experiments were still viable, while more than half the air-dried seeds were not.

Agricultural Marketing Service seed analyst Susan Maxon prepares seeds for freeze drying. The original 1976 research was a joint ARS-AMS project. (1185X1321-18)

Woodstock, a plant physiologist with the Agricultural Research Service, kept the freeze-dried seeds for 7 more years of storage at room temperature and found little sign of deterioration.

The original research in 1976 showed that freeze-drying markedly improved storage life of onion, pepper, and parsley seeds at temperatures between 106° and 133°F (40° to 50°C). These temperatures are equivalent to those in the Tropics and subtropics.

Woodstock says freeze-drying works very well in combination with air-drying. First, seeds are air-dried to about 10 percent seed moisture and then freeze-dried down to about 5 percent.

Air-drying can easily reduce seeds to about 10 percent, but after that point it becomes difficult, requiring either high or prolonged heat, both of which can damage seeds.

Woodstock believes that onion seeds and possibly other vegetable seeds dried by this two-step method can be sealed in moisture-proof packets and stored for many years at room temperature or indefinitely at sub-freezing temperatures.

Lowell Woodstock is at the USDA-ARS Seed Research Laboratory, Bldg. 006, BARC-West, Beltsville, MD 20705. ■

New Detector for Hidden Injuries in Fruit

Invisible wounds caused by stress to fresh fruits and vegetables can be found with a new, rapid technique that measures delayed light being emitted from chlorophyll molecules.

The technique is designed to help reduce the estimated 20 percent of all fresh produce picked in the United States that never reaches the consumer, says Agricultural Research Service horticulturist Judith A. Abbott. It can spot injuries from excessive chilling, sunburn, or air pollution, before any visible signs appear.

To find these injuries, Abbott and ARS colleagues at Beltsville, MD, measure the delayed light emission (DLE) of produce by shining light onto green and yet-to-ripen fruits and vegetables, such as tomatoes or peppers, for 7 millionths of a second. A detector measures the light emitted several seconds later from chlorophyll molecules.

Chlorophyll molecules—where a plant converts the energy from sunlight to plant food—both absorb and later emit light. If the produce has been injured, the molecules absorb light but emit about 20 percent of the amount healthy produce does. This effect signals internal stress several days before the injury becomes obvious.

The DLE instrument measures extremely low light levels of less than 1 percent of what a human eye can see. Previously, scientists had to cut open produce in order to test for internal injuries.

Abbott is studying chilling injury because it is costly for food distributors. It is caused by keeping fruit too cold for too long. "Our problem is that we don't yet know what controls the breakdown of tissue in produce," says Abbott. The answers may lie in the cell walls and membranes of the produce, which are controlled by enzymes and hormones.

"If we know what chemical changes happen to the fruit during chilling, then maybe we can develop ways to prevent them," Abbott says. "Presently, DLE is used only as a research tool. It has potential to help decide when to pick produce in the field or how long to store it, but that probably won't be for years," Abbott says.—**Deborah Aksler,** Beltsville, MD.

Judith A. Abbott is at the USDA-ARS Horticultural Crops Quality Laboratory, Bldg. 002, Room 113, BARC-West, Beltsville, MD 20705.

Horticulturist Judith Abbott checks tomatoes for visible injury before making delayed emission test for invisible wounds. (1085X1202-13)

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PATENTS

Sure Way To Diagnose Livestock Disease

More accurate diagnoses of bluetongue virus (BTV) and epizootic hemorrhagic disease virus (EHDV) may be on the way, thanks to antibodies produced by cloned hybrid cells.

These similar livestock diseases are sometimes confused by existing diagnostic methods. Agricultural Research Service scientists had earlier prepared hybrid cells which secrete monoclonal antibodies that identify only BTV. Now the picture is complete—cells have been prepared that secrete antibodies that identify the two EHDV types known to exist in this country without cross-reacting with any of the five known types of BTV.

Simple tests common to most diagnostic laboratories can be used to diagnose EHDV with monoclonal antibodies.

For technical information, contact M. Ann Whitehead, USDA-ARS, USDA-ARS, Rm. 401, Bldg. 005, Beltsville, MD 20705. *Patent Application Serial No. 06/708,613, "Monoclonal Antibodies to Epizootic Hemorrhagic Disease Virus Antigen."* ■

Curing Hides Faster

A fresh cattlehide preserved in just 1 hour, without salt, remained in excellent condition 6 days after treatment.

The hide was agitated in a drum with 20 percent butyl carbitol and 80 percent water for 1 hour at about 6 rpm and then allowed to drain. It was then stored in a plastic bag at room temperature.

This method has also been used to successfully preserve cattlehides with butyl carbitol acetate, diethyl carbitol, butoxy triglycol, and butoxy ethoxy propanol.

The preservative concentration can be reduced as low as 2 percent by adding an acid such as formic acid, a detergent/emulsifier, and an amount of water equal to 20 percent of the hide's weight.

Presently, cattlehides are preserved commercially by brining for about 12 hours with saturated salt solutions containing chemicals to kill microbes.

For technical information, contact William J. Hopkins, USDA-ARS, Hide Processing Research, 600 East Mermaid Lane, Philadelphia, PA 19118. *Patent No. 4,478,728, "Process and Compositions for Preserving Fresh Hides and Skins."* ■

Better Zinc, Iron, and Chromium Supplements

Just as picolinic acid in the body aids zinc absorption, artificial mixtures of the acid with zinc and other heavy metal salts produce dietary supplements that are more easily absorbed into the bloodstream.

Elemental metal and inorganic metallic salts have generally proven to be ineffective supplements, particularly for people with intestinal malfunctions that block absorption. Also, doses of one metal can cause side effects resulting from competition with other metals, and doses are often kept below the most effective amounts because of the metals' toxicity.

The picolinic acid-salt supplements avoid these problems because they are directly available for absorption into the system without competition from other metals, in the same form normally produced by humans.

For technical information, contact Phyllis E. Johnson, USDA-ARS Grand Forks Human Nutrition Research Laboratory, P.O. Box 7166, University of North Dakota, Grand Forks, ND 58202. *Patent No. 4,315,927, "Dietary Supplementation with Essential Metal Picolinates."* ■

How To Obtain a License for USDA Patents

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Copies of existing patents may be purchased from the Commissioner of Patents and Trademarks, U.S. Patent and Trademark Office, Washington, DC 20231. Copies of pending patents may be purchased from National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161. ■